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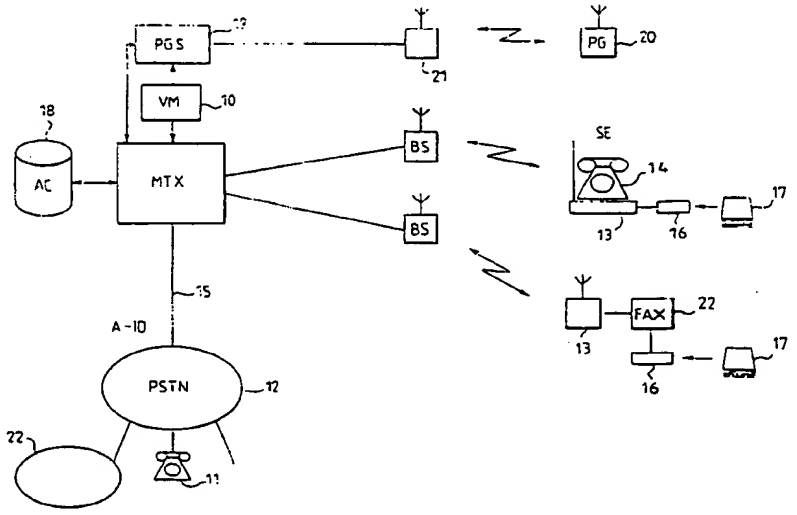

(57) Abstract

The invention relates to a radio system, comprising an exchange (MXT), base stations (BS) and subscriber terminals (13, 14, 22). According to the invention, the system comprises virtual subscribers each having a personal telephone number which is not permanently associated with any specific one of the subscriber terminals. At least one of the subscriber terminals (SE, 13, 14, 22) is adapted to be shared by virtual subscribers so that the virtual subscriber is capable of making a temporary association with the shared subscriber terminal and the personal telephone number of the virtual subscriber for the use of the terminal. The exchange forwards calls to the virtual subscribers to a voice mail device (10) to which a calling subscriber is able to leave a voice message.

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A radio system

The invention relates to radio systems.

An efficient and cost effective telecommunications infrastructure plays a key role in promoting the economic growth and social development of society. In building conventional cable-based telecommunication networks, the most expensive and time-consuming part is the installation of the subscriber lines that connect each subscriber to a local exchange.

It is therefore economically feasible to replace subscriber cables with a radio link which can be established easily and quickly to connect subscribers to the public switched telephone network (PSTN) in areas where no subscriber lines are available and the installation is too expensive, slow or otherwise impractical. Like a conventional mobile radio network, the subscriber network comprises base stations which are connected to the exchange and to which the subscriber terminals (mobile radios) establish a radio connection. This kind of system is called a Wireless Local Loop (WLL). As the WLL radio system is usually an extension of the conventional public switched telephone network, it utilizes a conventional telephone network numbering scheme. Alternatively, it may utilize a mobile network numbering scheme. A call to the telephone number of a WLL subscriber results in the routing of the call to one and the same exchange and then paging of the subscriber over the radio path by the base station. Each subscriber usually has his/her own WLL telephone set or telefax terminal to which the subscriber can answer in a normal way. It is possible to connect any conventional telephone set to the WLL radio system. From the subscriber's point of view, the radio path is transparent, and establishes a

point-to-point connection via a base station between the WLL telephone set and the telephone exchange.

In developing countries and other low-income areas, however, all people willing to have their own telephone set cannot necessarily afford to buy one as the telephone set is relatively expensive. One solution to this problem is to use the same type of public telephone as that used in fixed networks, i.e the user can make an outgoing call from the public telephone. However, there still remains the problem that people cannot be reached individually by telephone unless prearrangements are made that the person will be at the specific public telephone at a specific time.

One object of the invention is to eliminate the above problem and to provide a wireless two-way public telephone service.

This is achieved by means of a radio system according to the invention, comprising an exchange; base stations; subscriber terminals; virtual subscribers each having a personal telephone number which is not permanently associated with any specific one of the subscriber terminals; at least one of the subscriber terminals being adapted to be shared by virtual subscribers, the virtual subscriber being capable of making a temporary association with the shared subscriber terminal and the personal telephone number of the virtual subscriber for the use of the terminal; means for forwarding calls terminating to said personal telephone numbers to a voice mail means to which a calling subscriber is able to leave a voice message which the called subscriber is able to retrieve.

In the invention the radio system comprises not only conventional subscribers each having a personal telephone number and subscriber terminal but also

subscribers each having a personal telephone number which is not permanently associated with any subscriber terminal, or access point in the radio system. The subscribers having a personal telephone number not permanently associated with any specific terminal equipment are called virtual subscribers. A virtual subscriber may have no personal subscriber terminal at all. There are also subscriber terminals adapted to be shared by virtual subscribers, the virtual subscriber being capable of making a temporary association with the shared subscriber terminal and the personal telephone number of the virtual subscriber for the use of the terminal. The shared subscriber terminal may comprise a card reader means for receiving a user card of the virtual subscriber for making said temporary association with the shared terminal and the telephone number of the virtual subscriber for the use of the terminal. The virtual subscribers may for example use a shared "public phone".

When a call is made to the telephone number of the virtual subscriber, it may be forwarded to a voice mail service. The caller may leave a voice message to the voice mail, and the called subscriber may later retrieve the voice message by using a terminal which is adapted for shared use by any of the virtual subscribers. In the preferred embodiment of the invention, a selective alarm is given to the virtual subscriber immediately when a call is received to the subscriber's telephone number. According to one embodiment of the invention, at least some of the virtual subscribers having a subscriber-specific radio pager for the purpose, and a page is sent to the pager in response to calls to the subscriber's telephone number. When alarmed by the pager, the virtual

subscriber is immediately aware of the call made to him, and may, at his earliest convenient, make a temporary association with one of the subscriber terminals and call to the voice mail service in order to listen to the voice message. Due to the invention all the virtual subscribers are accessible at their personal telephone number although they do not have any personal subscriber terminal. A simple bleeper type pager is usually sufficient for the subscriber. The price of such a pager is only a fraction of that of a personal subscriber terminal. The telephone services can thus be afforded by a maximum number of subscribers. The concept of virtual subscriber also allows virtual subscribers to "roam" in the radio system by making above described temporary associations with subscriber stations, also in a case where the virtual subscriber actually owns a personal subscriber station but there is no permanent association with the personal station and the personal telephone number of the subscribers. The virtual subscriber is, however, capable of making said temporary association with his/her private station. The term "shared subscriber station" used herein is intended to include also such private subscriber stations.

Also a separate on-line database may be provided which contain subscriber data of the virtual subsribers as well as accounts for on-line call charging. Individual service profiles may be provided for the virtual subscribers in the on-line database. When the temporary association is made with a subscriber station and the personal telephone number of the subscriber, also the subscriber data of the subscriber, including charging principles and service profiles are temporarily associated with the terminal.

In the following the invention will be described in more detail by means of embodiments with reference to the attached figure, which illustrates schematically a radio system according to the invention.

The present invention may be applied in any radio system used as a WLL to replace wired subscriber lines between the public switched telephone network and subscribers. However, the invention is not restricted to WLL system only. On the contrary, the concept of virtual subscribers and other concepts of the present invention may be applied also in mobile radio networks generally. The attached figure illustrates schematically a cellular radio system according to the invention which is based on the utilization of prior art cellular networks, such as NMT. The WLL network may even be integrated in a conventional mobile radio network so that there are both WLL subscribers and mobile subscribers within the same network.

The radio system shown in the figure comprises a mobile exchange MTX; a plurality of base stations BS; and a great number of subscriber terminals SE1, SE2 and SE3. Like a conventional mobile exchange the mobile exchange MTX comprises a switch for switching calls, and a call control computer for controlling all signalling between the subscriber terminals SE and the radio network during the call set-up, call and call termination, and for allocating radio channels on a call-by-call basis for radio connections between the base station BS and the subscriber terminals SE. The exchange MTX of the radio system also has a connection 15 to a public switched telephone network PSTN 12 and through it to PSTN subscribers 11 or other networks 22 and their subscribers.

The base station BS may also be implemented like

a base station in a conventional mobile radio system although its elementary units consist of a number of transceivers the precise number of which is determined on the basis of traffic capacity requirements.

The WLL subscriber terminal SE typically comprises a mobile radio part 13 and a conventional telephone set 14. The mobile radio part operates as an interface unit to the radio path and offers the subscriber a normal subscriber line to which the subscriber may interface the conventional telephone set 14. The radio path is preferably scrambled. The mobile radio part 13 may comprise an adapter to offer an interface for a modem or a telefax terminal 22 as well. From the subscriber's point of view, the use of the WLL telephone set resembles that of a conventional telephone set of the fixed telephone network as closely as possible. The radio part 13 of the WLL subscriber terminal is usually placed on a desk and the conventional telephone set is placed on top of the radio part unit. The subscriber terminal, however, may also be in the form of a portable phone or a public card phone.

In the prior art WLL radio systems each subscriber has his/her own subscriber terminal and an associated telephone number. The mobile exchange MTX links the telephone number to the subscriber terminal in the area of a specific base station BS. When a call is made to the telephone number, the mobile exchange initiates the paging of the subscriber terminal within the area of the base station BS indicated by the telephone number or within a location area containing several base stations. When the subscriber terminal responds to the paging, the mobile exchange MTX allocates a radio channel to the call and sets up a call between the subscriber terminal SE and the mobile

exchange MTX e.g. by call set-up signalling complying with the conventional mobile radio system, and then switches a connection between the called subscriber terminal and the calling subscriber by the internal switch of the mobile exchange. The calling subscriber may be a WLL subscriber, a mobile subscriber or a subscriber 11 in the public switched telephone network PSTN 12. In this kind of system the subscriber is always individually accessible as he/she has a personal telephone number and personal subscriber terminal.

The WLL radio system may also comprise public phones which the subscriber may use to make outgoing calls. Those who cannot afford to buy a personal subscriber terminal may use such public subscriber terminals for outgoing calls, whereas they are not individually accessible by phone like those who have a personal telephone number and subscriber terminal.

According to the invention this problem is solved so that a larger number of people, up to several hundreds of people, each having a personal telephone number, share a common subscriber terminal. The subscribers having a personal telephone number but no permanent association with any specific telephone are called virtual subscribers. The mobile exchange MTX routes calls to telephone numbers of the virtual subscribers to a voice mail means 10 to which the calling subscriber may leave a voice message which can be retrieved by the called virtual subscriber at least by means of the shared subscriber terminal. In order that the virtual subscriber could be informed of a voice message addressed to him/her as soon as possible, at least some of the virtual subscribers are provided with a radio pager 20 to which the call control of the mobile exchange MTX or the voice mail

10 sends a page via the subscriber's home base station BS or the base stations of the home location area when a call is received to the subscriber's personal telephone number. Paging may be performed via the base station network of the radio system e.g. by a radio message similar to those used to call the subscriber terminals in the system. The paging message, however, is provided with a pager-specific identity code. When the pager receives a page, it gives the subscriber an acoustic, optical or other appropriate alarm which indicates the subscriber that he/she has received a call. If a radio paging system independent of the WLL radio system is available, the paging may be initiated by the voice mail 10 or the call control of the MTX and then performed via the transmitters 21 of the separate paging system 19. The transmitters 19 of this separate radio paging system may also be integrated in the base stations BS of the radio system.

The pager 20 may inform the subscriber of the reception of the paging message by giving an acoustic or optical alarm or a numeric/alphanumeric message on the display of the pager. The numeric/alphanumeric message is preferably the telephone number given by the calling subscriber, to which number the subscriber may call past the voice mail.

The shared subscriber terminal SE according to the invention may be e.g. a so-called card telephone which does not allow the use of the telephone until a valid subscriber card or pay card is inserted into its card reader 16. The card may be a magnetic stripe card, a chip card (smart card) or a Subscriber Identification Module (SIM). The subscriber card may contain subscriber data and e.g. the number of the subscriber's voice mailbox and a service code which initiates an automatic call to the voice mail 10. The

pay card is a so-called prepaid card which entitles to a predetermined number of calls or other services. The pay card contains information about the prepayment made by the subscriber for calls and other services in the system. The card 17 may also be a combined subscriber and pay card.

In the preferred embodiment of the invention the the monetary value associated with each card is not stored in the user card. Instead, the user card contains a unique number which acts as a key to an on-line database 18 within or outside the radio system. The database 18 may be centralized database or a distributed database interconnected with the exchange MTX via bidirectional real-time comunications links. The monetary values or the prepayments or credit limits associated with each user card are stored in the database 18. The database 18 may further contain the subscriber number as well as other subscriber specific data, such as service profiles for the subscriber. The external on-line database 18 which is independent from MTX allows creation of individual and various subscriber service profiles, e.g. call destination profiles and call originating profile.

The call destination profiles may include a list of telephone numbers or sequencies of digits, such as country codes, to which it is not allowed to make calls by the subscriber. Alternatively, the service profiles may include a list of allowed telephone numbers or sequencies of digits.

The call originating profiles may include information on the areas of the radio network in which originating calls are allowed to or prohibited from. This area information may be in form of a list of radio cells. The subscriber may have different kinds of destination profiles in different areas or cells

allowed to the subscriber by the originating profiles. For example, the charging of the calls may be affected based on different charging principles in different areas and cells. The charging principles may include different tariffs for different cells or areas, and different accounts in the on-line database 18 for different cells or areas. For example, the home of the subscriber may be located in one cell in which calls are charged from a personal account of the subscriber using a first tariff, whereas the office of the subscriber may located in another cell in which calls are charged from an account of the office using a second tariff. The tariff used may also vary with the time of the day.

In the beginning of the call, when the subscriber card of the virtual subscriber is inserted to a card reader of the subscriber terminal, such as a shared terminal, the subscriber data is retrieved from the database 18 to the subscriber terminal, and possibly also to the MTX, on the basis of a subscriber specific identity, such as a card number. The subscriber terminal may store the received subscriber data, including the service profiles, in its memory, being thereby initialized as a terminal of the virtual subscriber, i.e having a temporary association with the telephone number of the virtual subscriber. Alternatively, MTX may signal services profiles to the subscriber terminal later, if necessary, as will be described below. If the retrieved data indicates that the repaid balance or credit of the subscriber is sufficient for a call and the service profiles of the subscriber allow the call, the permission for the call will be issued either by the subscriber terminal or the MTX. When the permission for the call is obtained, the subscriber number of the subscriber is forwarded

to the MTX from the subscriber terminal. The MTX is provided with the subscriber data, such as the service profiles, for the forwarded subscriber number, and processes the call according to the subscriber data. If not already available, the subscriber data of the virtual subscriber is retrieved from the database 18 to the MTX.

In a beginning of an originating call the MTX examines on the basis the originating profiles of the subscriber whether the subscriber is authorized to make calls in current location, eg. in a current cell. In case the subscriber is not allowed to make a call in the current location, the MTX terminates the call setup. In order to avoid repeated call attempts from the prohibited areas, the MTX may signal a list of the the cells allowed to the subscriber terminal. The subscriber terminal temporarily stores the received area data in its memory, and subsequently makes call attempts only in the cells in the list.

Charging data is collected during the call, either by the subscriber terminal or the MTX, and the respective account is updated in the on-line database 18 when the call is terminated. The charging may follow, for example, a procedure which will be described below.

All the subscriber data is erased from the memory of the subscriber terminal when the subscriber card is removed from the terminal. No calls, exclusive emergengy calls, can be made by a subscriber terminal without a subscriber card.

The content of on-line database 18 may include the following information elements, for example: card number, subscriber number, originating profile, destination profile, monetary information, such as balances and credit limits, and optional services such

as voice mail subscription. The database may be supported by a suitable subscription and account management, including preferably also user card management.

In one embodiment of the invention the radio system comprises a database 18 which contains a record of the prepayments made by each subscriber. The exchange MXT informs the database 18 of the price of the services the subscriber has used at each specific time, and the prepayment balance of the subscriber is charged by this amount. When the prepayment has been spent, the subscriber is barred from the usage of the services of the radio system. This may take place e.g. in such a way that the database 18 requests the radio system (the exchange MXT) to invalidate the subscriber/telephone number. Alternatively, the radio system (the exchange MXT) may send a request to the database 18 to check the prepayment balance of the subscriber whenever the subscriber requests a service. The prepayment practice, i.e. the use of the off-line subscriber and/or pay card or the on-line database 18, is a safe way of offering services in underdeveloped areas where aftercharging is uncertain if not impossible.

When the subscriber wants to retrieve the call received at the voice mail, he/she inserts the subscriber and/or pay card 17 into the card reader of the subscriber terminal, calls to the number of the voice mail service (automatically or manually), and then gives his/her personal password, e.g. by the DTMF keys of the telephone, whereafter he can listen to the voice message in the voice mail.

The voice mail PGS may comprise a messaging service to which the calling subscriber can leave a telefax message. The messaging service stores the

telefax message. When the called subscriber calls the voice mail, he gives the messaging service the number of the telefax terminal 22 to which the stored telefax is to be sent.

The figures and the description related to them are only intended to illustrate the present invention. In its details the radio system according to the invention may vary within the scope of the attached claims.

Claims:

1. Radio system, comprising

an exchange (MXT);

base stations (BS);

subscriber terminals (SE);

virtual subscribers each having a personal telephone number which is not permanently associated with any specific one of the subscriber terminals,

at least one of the subscriber terminals (SE, 13, 14, 22) being adapted to be shared by virtual subscribers, the virtual subscriber being capable of making a temporary association with the shared subscriber terminal and the personal telephone number of the virtual subscriber for the use of the terminal,

call control means (MXT) forwarding calls to said personal telephone numbers to a voice mail means (10) to which a calling subscriber is able to leave a voice message which the called subscriber is able to retrieve.

2. Radio system according to claim 1, wherein the system comprises means (19, 20, 21) for selectively alarming the virtual subscriber in response to a call received to the subscriber's telephone number.

3. Radio system according to claim 2, wherein at least some of the virtual subscribers a subscriber-specific radio pager device (20) to which a page is sent in response to a call to the virtual subscriber's telephone number.

4. Radio system according to claim 1, 2 or 3, wherein the shared subscriber terminal comprises a card reader means (16) for receiving a user card (17) of the virtual subscriber for making said temporary association with the shared terminal and the telephone number the virtual subscriber for the use of the

terminal.

5. Radio system according to claim 4, wherein the subscriber and/or pay card (17) contains information about the prepayment made by the subscriber.

6. Radio system according to any of claims 1 to 4, wherein the radio system comprises a database (18) containing a record of prepayments made by each subscriber.

7. Radio system according to any of claims 1 to 4, comprising an on-line database (18) for maintaining a monetary value associated with each user card and/or subscriber.

8. Radio system according to any of claims 1 to 4 or 7, comprising an on-line database (18) for maintaining individual call destination service profiles for each subscriber, said services profiles including a list of telephone numbers or sequencies of digits, such as country codes, to which it is not allowed to make calls by the subscriber, or alternatively, a list of telephone numbers or sequencies of digits allowed to the subscriber.

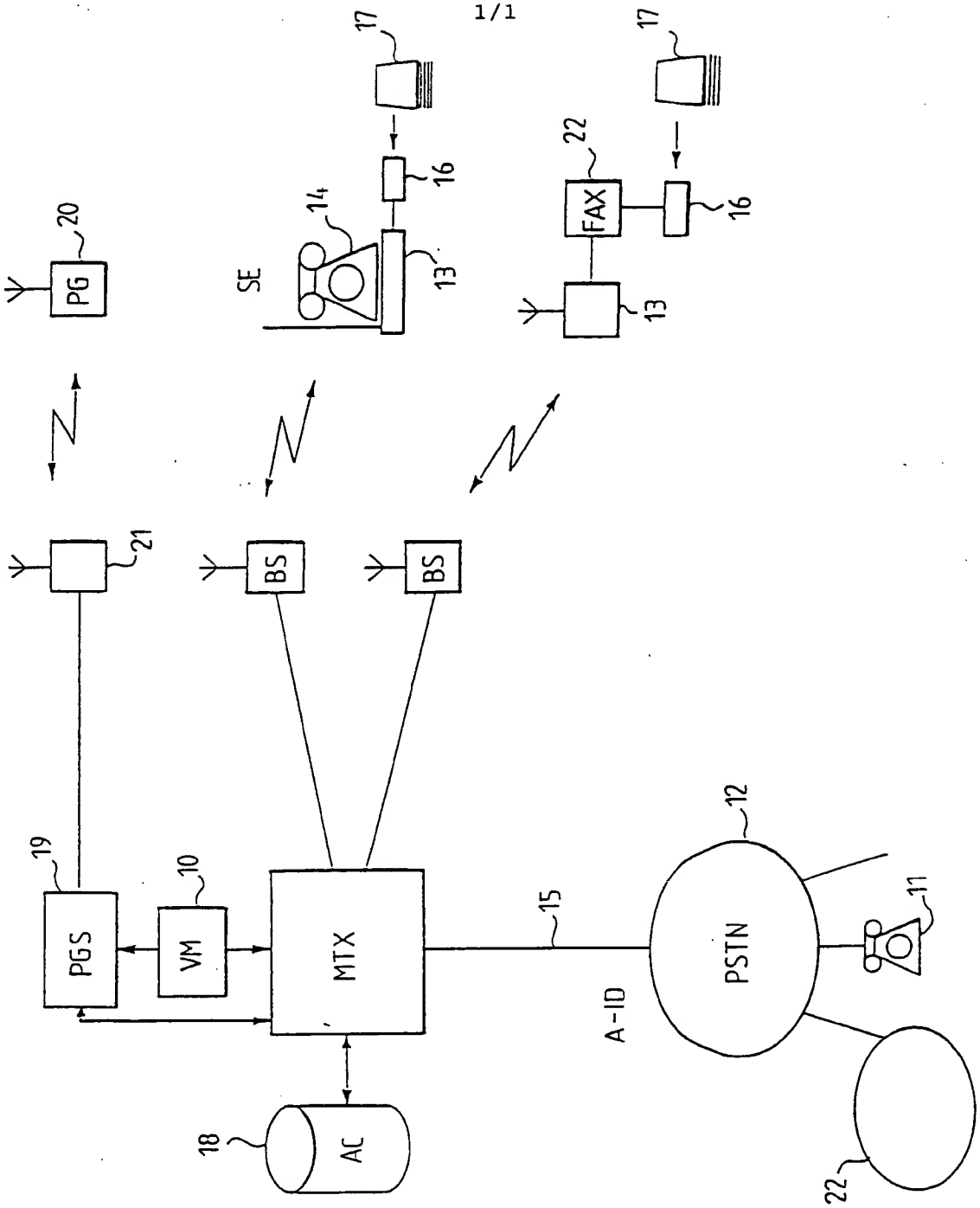
9. Radio system according to any of claims 1 to 4 or 7 to 8, comprising an on-line database (18) for maintaining individual call originating service profiles for each subscriber, said services profiles including information on the areas or cells of a radio network in which originating calls are allowed to or prohibited from.

10. Radio system according to claim 9, wherein different kinds of destination profiles are provided for a subscriber in different areas or cells allowed to the subscriber by the originating profiles.

11. Radio system according to claim 10, wherein charging of the calls may be affected based on

different charging principles in different areas and cells, such as different tariffs for different cells or areas, or different accounts in the on-line database for different cells or areas in the radio network.

12. Radio system according to any of claims 7 to 11, wherein the on-line database is accessed by the exchange or the subscriber terminal when a user card is inserted to the subscriber terminal, and the subscriber terminal is initialized by the subscriber data retrieved from the on-line database on basis of an access data obtained from the user card.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INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 94/00301

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H04M 3/50, H04M 17/00
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: H04M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	SE, B, 469362 (TELEVERKET), 21 June 1993 (21.06.93), page 6, line 7 - line 12	1
Y		2-4
	--	
Y	EP, A2, 0121291 (VOICETEK CORPORATION), 10 October 1984 (10.10.84), page 3, line 15 - line 19	2-3
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Y	FI, B, 78374 (SONDI OY), 31 March 1989 (31.03.89), claim 4	4
A		5-12
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Date of the actual completion of the international search	Date of mailing of the international search report
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INTERNATIONAL SEARCH REPORT

Information on patent family members

01/10/94

International application No.
PCT/FI 94/00301

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
SE-B- 469362	21/06/93	EP-A,A- 0571345	24/11/93
		GB-A- 2267197	24/11/93
		SE-A- 9202168	21/06/93
EP-A2- 0121291	10/10/84	SE-T3- 0121291	
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